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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B41L 1/32 — A1

(11) International Publication Number: WO 91/19613

(43) International Publication Date: 26 December 1991 (26.12.91)

(21) International Application Number: PCT/US91/04249

(22) International Filing Date: 10 June 1991 (10.06.91)

(30) Priority data:
2,019,183 18 June 1990 (18.06.90) CA

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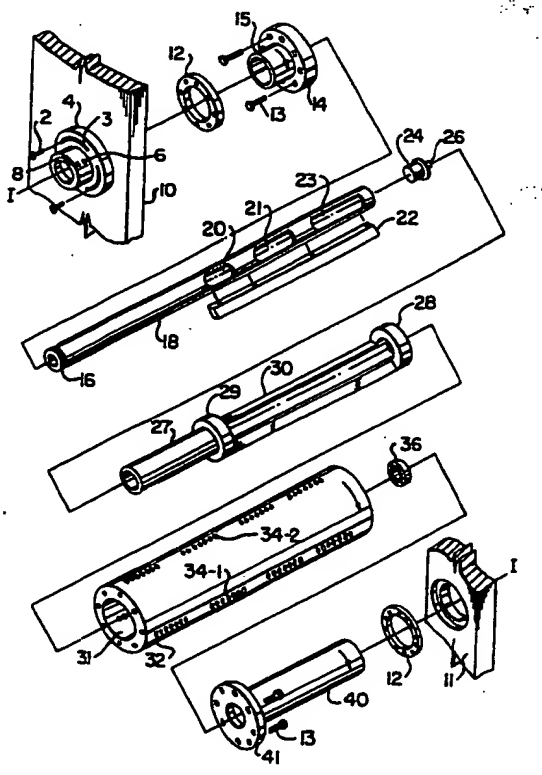
(81) Designated States: AU, BR, FI, JP, NO, US.

Published
With international search report.

(54) Title: PAPER CONVERTING MACHINE VACUUM ROLL

(57) Abstract

A vacuum roll for paper handling machine, such as is used in interfolding paper machinery, is described in which an outer rotating roll member (32) rotates around an internally coaxial static vacuum feed and control means (18). Both the length of time for which vacuum is applied, and the part of the circle of rotation over which it is applied, can be varied from outside the machine and whilst the machine is running.



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PAPER CONVERTING MACHINE VACUUM ROLL

This invention is concerned with paper web handling rolls, of the type wherein a paper web is temporarily held against a part of the surface of the roll by means of a vacuum created within the roll.

In a number of paper web handling operations, for example interfolding cut sheets to obtain a stack of products, such as paper towels or facial tissues, and folding cut sheets such as paper table napkins, a folding roll is used. These rolls are generally cylindrical, and rotate at the same speed as the paper web passing over them, which is being cut and/or folded. The paper web is held onto the roll for a short period of time by means of a combination of an evacuated chamber within the roll, and a plurality of small holes through the roll communicating with the vacuum chamber by way of a narrow slot like aperture extending internally along the length of the roll. As the roll rotates, vacuum is applied through the holes to one surface of the paper web, thus temporarily holding it onto the roll. The level of vacuum applied is controlled to be enough to hold the paper web and yet is insufficient to cause marking or damage to the web.

It is also necessary to be able to control the period of time, which is equivalent to an arc of the circle of rotation of the roll, during which vacuum is applied to the paper web.

In the known vacuum rolls of this type, the vacuum feed is connected to the chamber in the roll by means of a sleeve or shoe which has an inner arcuate slot on a face which bears against the end of the roll, which includes a cooperatingly placed bore communicating with the vacuum chamber. For part of the cycle of rotation of the roll the bore will be open to the arcuate slot, thus evacuating the roll chamber, and for part of the cycle of rotation the bore will be open to the atmosphere, thus releasing the vacuum. Examples of this form of construction are to be found in U.S. 3,338,575; 3,489,406; 3,490,762; 4,778,441; 4,564,418; and 4,254,947.

Apart from the fact that such rolls are quite noisy in operation (see U.S. 4,564,418) they have another quite important disadvantage. It is impossible to adjust either the position around the roll cycle of rotation at which vacuum is applied, or the period of time for which it is applied, without stopping the paper-handling machine. This is so because the shoe having the inner arcuate slot has to be

inside the main machinery framing bearing against the end of the rotating roll, and the support shaft for the roll essentially has to pass through the shoe. Whilst it might be feasible to change the timing with the machine moving, by rotating the shoe slightly, to change the length of time for which vacuum is applied requires removing the shoe and altering the internal arcuate slot. This cannot be carried out whilst the machine is running.

In a similar way, the evacuated perforated paper handling rolls commonly used in paper making machines which comprise an inner vacuum chamber and an outer drum-like perforated shell cannot easily be adjusted. In these devices, the vacuum is applied to the inside of the shell by a radial slot along the length of the shell, which is positioned where it is needed. The width of the slot is predetermined and not adjustable, and further the vacuum is continuously applied to the inside of the shell, to aid in part in removing water from a wet paper web. A typical device of this type is described in U.S. 4,714,523.

This invention seeks to overcome these difficulties, and to provide a paper web handling roll of this general type in which both the timing of vacuum application, and the length of time of vacuum application are adjustable from outside the machine by adjustment of parts which do not rotate when the machine is running. It therefore follows that adjustment of both timing and duration can be made whilst the paper handling machine is in operation.

Thus in its broadest embodiment this invention provides a paper machine vacuum roll together with a vacuum supply and control means, wherein the vacuum supply and control means is stationary, within, and substantially coaxial with the vacuum roll, consisting essentially of in combination:

(i) a vacuum roll having a substantially cylindrical outer surface and a coaxial inner bore communicating with the outer surface by a plurality of holes comprising at least one row of radial holes along a line substantially parallel to the axis of rotation of the roll;

(ii) journal means at a first end of the roll;

(iii) journal means at a second end of the roll including a substantially cylindrical coaxial aperture communicating with the inner

bore and adapted to receive the vacuum supply and control means therethrough;

together with a vacuum supply and control means comprising:

(iv) an outer vacuum box means in a vacuum tight-sealing relationship with the inner bore comprising a first sealing means in cooperating relationship with the inner bore adjacent the first end of the roll, a first substantially cylindrical member attached to the first seal and extending substantially for the length of the inner bore, a second sealing means attached to the first cylinder and in cooperating relationship with the inner bore adjacent the second end of the roll, and a second cylindrical member extending through the coaxial aperture of the second journal means, wherein the first cylindrical member includes at least one arcuate slot extending for the length of the cylinder between the first and second sealing means;

(v) an inner vacuum box means comprising a third cylindrical member extending through the second and first cylindrical members including at least one longitudinal arcuate slot communicating with the or each arcuate slot in the first cylinder, the third cylindrical member having attached thereto adjacent one edge of the at least one slot, and extending for the length of the at least one arcuate slot in the first cylindrical member, a radially extending sealing means in cooperating sealing relationship with the inner bore and with the ends of the arcuate slot in the first cylindrical member;

(vi) clamping means whereby the second and third cylindrical members are retained in desired positions whilst the vacuum roll rotates; and

(vii) vacuum pump means connected to the third cylindrical member.

Preferably the vacuum roll includes at least two, and more preferably at least three rows of radial holes.

Preferably, the first cylinder includes one arcuate slot which extends for at least 180°.

Preferably, the third cylinder includes a third journal means, such as a roller bearing, adjacent the first sealing means and in cooperating engagement with the vacuum roll adjacent the first journal means.

The invention will now be described by way of reference to the embodiment in the drawings, in which:

Figure 1 shows the parts of a roll in a disassembled state;

Figure 2 shows in part cross-section the roll of FIgure 1 assembled;

Figure 3 shows a cross-section substantially on the line II-II of the assembled roll of Figure 2; and

Figure 4 shows an alternative construction of Figure 3.

In these figures like parts are similarly numbered. It is also to be noted that some parts of Figure 1 are omitted for clarity from Figure 2.

Referring first to mainly Figures 1 and 2, the line I-I denotes the common cylinder axis for all of the parts making up the roll, both the stationary vacuum feed and control means, and the rotating roll parts. The roll is supported in the machine framework, shown schematically at 10, 11 by suitable bearings 12. Outside the framing at one end, as at 10, the timing hub 4 is located, which is held in place typically by screws 2 in the slots 3. Alternatively toggle clamps could be used. The hub 4 includes the locking set screws 6 and 8. The functioning of these parts will be described below.

One end journal, 15, of the roller runs in bearing 12, which typically is a ball bearing, in the frame 10. Through this journal extends the vacuum supply and control means, comprising the first, second and third cylinders. The innermost third cylinder 18 has a vacuum connection at 16, and is provided with three arcuate slots 20, 21 and 23 which function as vacuum ports. A single slot could be used but is less effective. At its other end, the cylinder is closed with a plug 24, typically by welding, which also includes a bearing spigot or stud 26. Adjacent one side of the slots 20, 21 and 23 is attached the sealing strip 22 (see Figure 3).

The third cylinder fits inside the first and second cylinders, with the vacuum connection 16 protruding beyond the second cylinder 27. The ends 27 and 18 of the second and third cylinders are cut to a length such that when the roll is assembled and installed, cylinder 27 can be engaged by the hub set screw 6, and 18 by the hub set screw 8. The first cylinder comprises a vacuum box, and includes the first and second sealing means 28 and 29, and the slotted first cylinder 30. As

can be seen in Figure 3, the arcuate slot cut in the first cylinder can entail cutting away more than half of the cylinder. The sealing strip 22 is the same length as the arcuate slot (Figure 2).

These static members fit inside the inner bore 31 of the rotating vacuum roll 32. This roll has three rows of radial holes 34-1, 34-2 and 34-3. It is known to use both fewer rows of holes - either one or two - and also more than three in such rolls. The roll 32 is attached to the flange 14 adjacent the journal 15, and to the flange 41 adjacent the journal 40 typically by bolts 13. The journal 40 is carried in the bearing 12 in the frame member shown schematically at 11. The roll will also be driven from this end by conventional means (not shown). It is also convenient to support the inner end of the vacuum supply and control means for example by way of the bearing 36 inserted into the bore 39 of the flange 41, which receives the spigot 26.

The functioning of the roll can be seen mainly from Figure 3. It is assumed the roll is rotated in the direction X. It is to be noted that only the roll cylinder 32 rotates: the remaining parts are static. As the roll rotates, each hole 34-1, 34-2 and 34-3 in sequence passes over the vacuum chamber A, and is in communication with it over the arc C. The hole will then pass over the sealing strip 22 and over the unevacuated chamber B, which is essentially at atmospheric pressure and is on the trailing side of the seal 22, in the direction of rotation of the roll. The vacuum remaining in the the holes 34 is thus vented, and the paper web released. Over the remainder of the rotation, the hole is sealed at its inner end. It can thus be seen that the amount of vacuum applied is determined by the pressure in the cylinder 18, and the time for which it is applied by the length of the arc C. Both of these are controlled externally: the pressure by the pump setting, and the arc by means of the hub 4 and set screws 6 and 8. By using these set screws, the arc C can both be altered in length, by rotating cylinder 18 relative to cylinder 30, and the timing moved around the cycle, by rotating both together. The timing around the cycle can also be adjusted by rotating the whole hub 4 within the range allowed by the slots 3. Further, as neither of these rotates with the cylinder 32, these adjustments can be made with the machine running.

There is a further advantage in this construction over the known rolls. In the known rolls, vacuum is applied from the end shoe, and also vented at the end of the roll. That is, all of the space corresponding to the chamber A in this invention is evacuated and vented each time the roll rotates. This both takes time, and is noisy. In the roll of this invention, chamber A is always evacuated and only the bores 34 are evacuated and vented as they pass over chambers A and B. This is both far quieter, and also faster, especially if the ports 20, 21 and 23 are correctly sized to get the best use of the available vacuum.

Furthermore, as the vacuum control and supply means is static, it is feasible easily to assist in venting the holes 34 as they pass over chamber B. As shown in Figure 4, an air pressure supply pipe 42, connected at several points as at 44 to the chamber B can be fitted inside the vacuum cylinder 18. By this means a positive pressure can be maintained in the chamber B, thus aiding in venting vacuum in the bores 34 as soon as they have passed over the sealing strip 22. A suitable connection is made to the air supply pipe 44 adjacent the vacuum connection 16 in this variation (not shown).

In the preceding description an embodiment is described in which there is a single sealed vacuum chamber. This invention is not limited to there being only one such chamber.

This construction can easily be adapted to a format in which there is more than one sealed chamber between the vacuum cylinder 18 and the inner surface 31 of the roll 32. The first cylinder will then have more than one arcuate slot, the ports 20, 21 and 23 will be duplicated, and more than one seal 22 will be required.

It is inherent in the proceeding description that the inner bore 31 is cylindrical. It need not be so, and in fact a tapered form of construction can be used in which the inner bore widens from the seal 28 toward the seal 29 somewhat. The sealing strip is then also machined to match the taper. In such a construction, by providing end thrust adjustment, to control entry of the spigot into the bearing 36, the fit of the two vacuum cylinders into the inner bore can be closely controlled. Experience has shown this is not necessary, and that provided adequate machining tolerances are maintained a cylindrical

construction is sufficient in which the inner bore has a substantially constant internal diameter.

The material chosen for the sealing strip is also of some importance since it is bearing against the moving inner face of the inner bore. Three satisfactory materials, each of which are fiber reinforced phenol- or urea-formaldehyde resins are Ryertex (Trade Mark) and Robco 22 (Trade Mark), obtainable from Solidur Canada Co. of Montreal, Quebec, and Ellslip (Trade Mark) obtainable from Beloit Canada Inc., Sorel, Quebec. These materials both appear to give an adequate seal life, and not to require any lubrication during service, especially if, as has been found with Ryertex, the material is soaked in a suitable lubricating oil for a period of time before use.

WHAT IS CLAIMED IS:

1. A paper machine vacuum roll together with a vacuum supply and control means, wherein the vacuum supply and control means is stationary, within, and substantially coaxial with the vacuum roll, consisting essentially of in combination:

(i) a vacuum roll having a substantially cylindrical outer surface and a coaxial inner bore communicating with the outer surface by a plurality of holes comprising at least one row of radial holes along a line substantially parallel to the axis of rotation of the roll;

(ii) journal means at a first end of the roll;

(iii) journal means at a second end of the roll including a substantially cylindrical coaxial aperture communicating with the inner bore and adapted to receive the vacuum supply and control means therethrough;

together with a vacuum supply and control means comprising:

(iv) an outer vacuum box means in a vacuum tight-sealing relationship with the inner bore comprising a first sealing means in cooperating relationship with the inner bore adjacent the first end of the roll, a first substantially cylindrical member attached to the first seal and extending substantially for the length of the inner bore, a second sealing means attached to the first cylinder and in cooperating relationship with the inner bore adjacent the second end of the roll, and a second cylindrical member extending through the coaxial aperture of the second journal means, wherein the first cylindrical member includes at least one arcuate slot extending for the length of the cylinder between the first and second sealing means;

(v) an inner vacuum box means comprising a third cylindrical member extending through the second and first cylindrical members including at least one longitudiual arcuate slot communicating with the or each arcuate slot in the first cylinder, the third cylindrical member having attached thereto adjacent one edge of the at least one slot, and extending for the length of the at least one arcuate slot in the first cylindrical member, a radially extending sealing means in cooperating sealing relationship with the inner bore and with the ends of the arcuate slot in the first cylindrical member;

(vi) clamping means whereby the second and third cylindrical members are retained in desired positions whilst the vacuum roll rotates; and

(vii) vacuum pump means connected to the third cylindrical member.

2. A vacuum rod according to claim 1 including at least two rows of radical holes.

3. A vacuum roll according to claim 1 including at least three rows of radial holes.

4. A vacuum roll according to claim 1 further including a bearing means interposed between the third cylindrical member and the inner bore adjacent the first end of the roll.

5. A vacuum roll according to claim 1 wherein a longitudinal seal divides the or each arcuate slot in the first cylindrical member into an evacuated part and an unevacuated part, the unevacuated part being on the trailing side of the seal in the direction of rotation of the roll.

6. A vacuum roll according to claim 5 further including positive air pressure supply means connected to the unevacuated part of the arcuate slot.

7. A vacuum roll according to claim 1 including a single arcuate slot in the first cylindrical member, a plurality of longitudinal slots in the third cylindrical member, and one radially extending sealing means.

8. A vacuum roll according to claim 5 including a single arcuate slot in the first cylindrical member, a plurality of longitudinal slots in the third cylindrical member, and one radially extending sealing means.

9. A vacuum roll according to claim 7 including three longitudinal slots in the third cylindrical member.

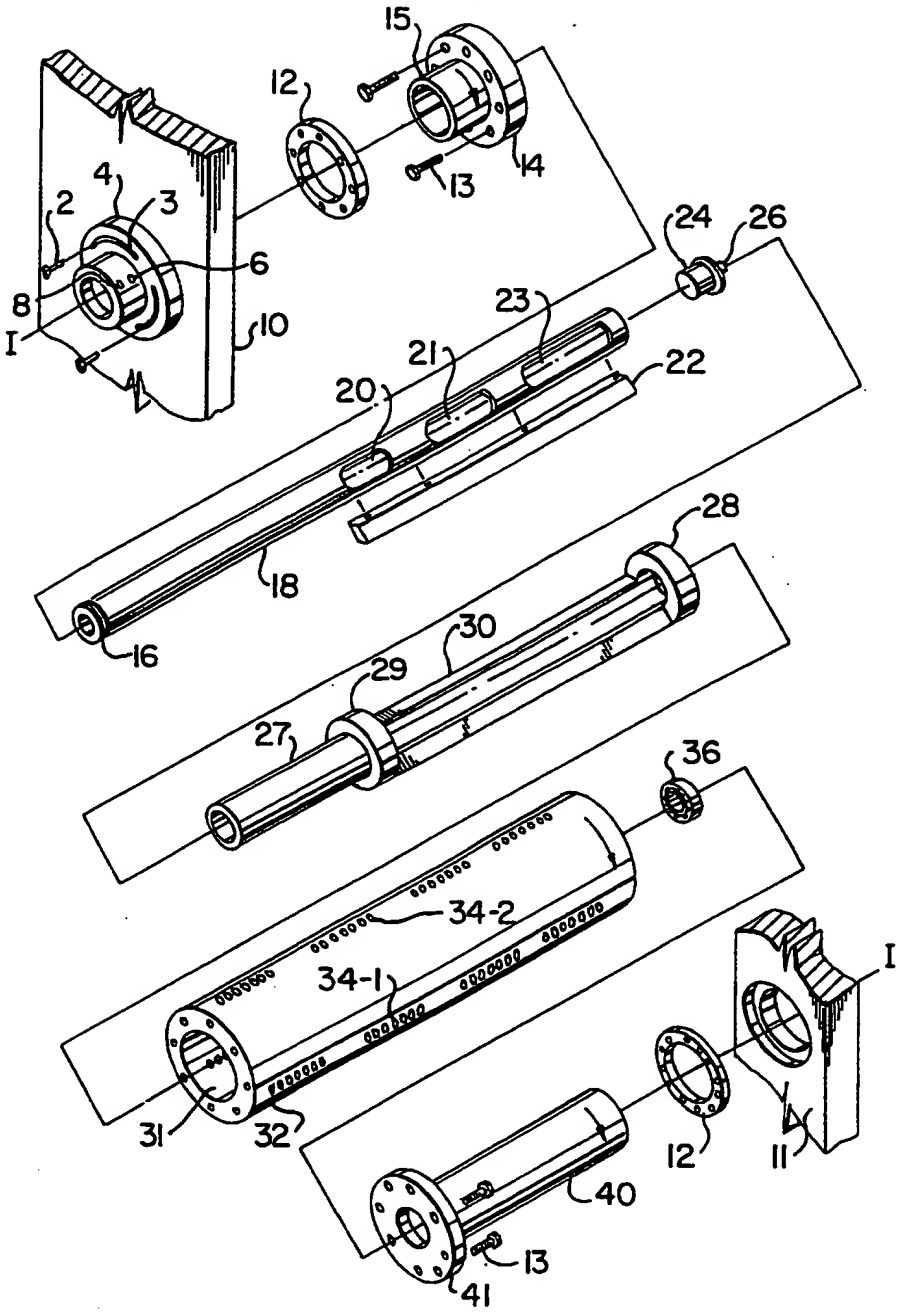
10. A vacuum roll according to claim 8 including three longitudinal slots in the third cylindrical member.

11. A vacuum roll according to claim 1 including two arcuate slots in the first cylindrical member, two pluralities of longitudinal slots in the third cylindrical member, and two radially extending sealing means.

12. A vacuum rod according to claim 5 including two arcuate slots in the first cylindrical member, two pluralities of longitudinal slots in the third cylindrical member, and two radially extending sealing means.

13. A vacuum roll according to claim 1 wherein the inner bore is tapered, being narrower at the first end of the roll than at the second.

14. A vacuum roll according to claim 1 wherein the inner bore is of substantially constant internal diameter.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22
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18
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34-2
34-1
31
32
I
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13
41

FIG. 1

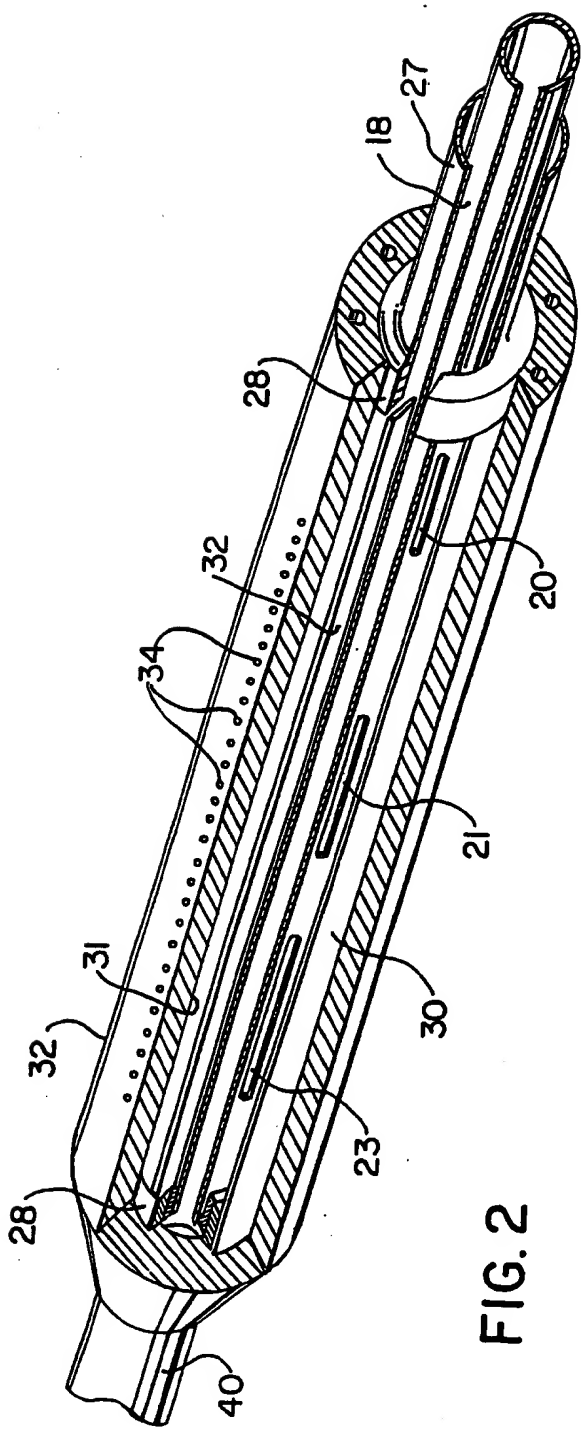
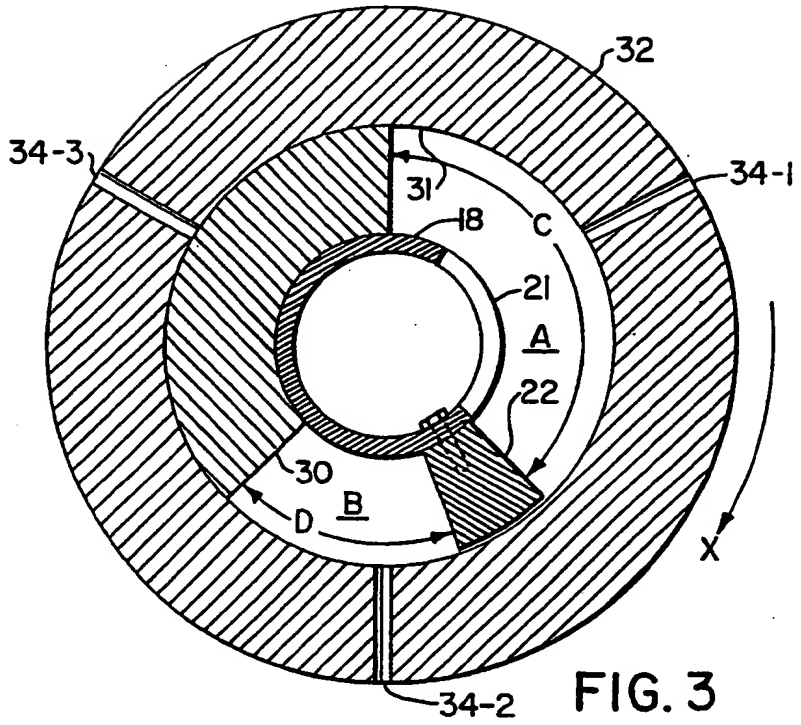


FIG. 2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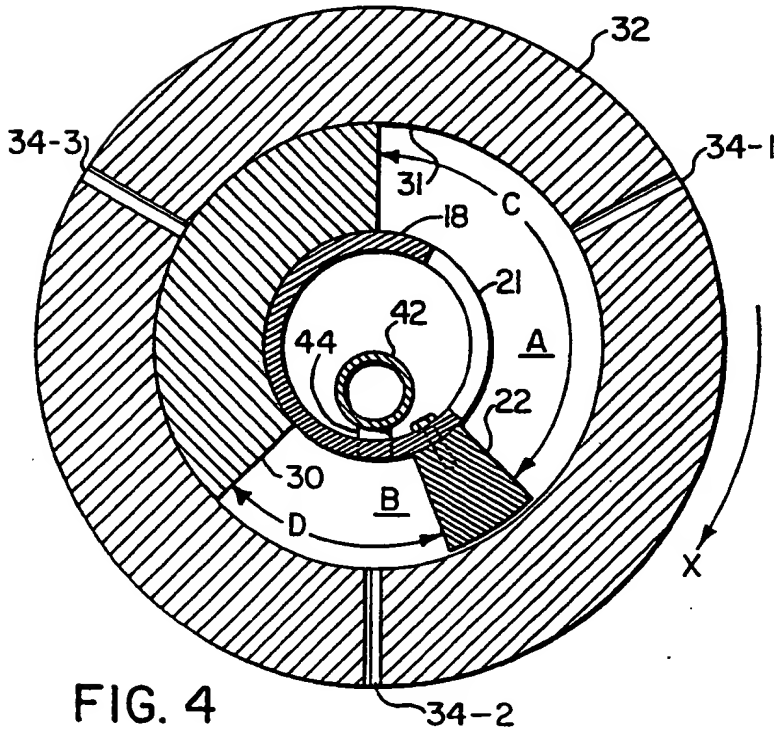
A
22
30
B
D
X
34-2

FIG. 3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34-3
34-1
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44
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D
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34-2

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/04249

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC 5 B41L 1/32

US CL. 270/39

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S. CL.	270/39,40,45-51 493/418,425,450

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US,A 3316819 COHN, 2 MAY 1967 (NOTE FIGURE 9)	1-14
A	US,A 387292 BRADLEY, 11 MARCH 1975 (ENTIRE DOCUMENT)	1-14
A	US,A 4254947 TROGAN, 10 MARCH 1980 (NOTE FIGURES 3-7)	1-14
A	US,A 4521209 DuFRESNE, 4 JUNE 1985 (ENTIRE DOCUMENT)	1-14

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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